3

Long-term Floristic Development of Woodland on Former Agricultural Land in Lincolnshire, England

G.F. PETERKEN

SUMMARY

The secondary woodlands that developed on former farmland in central Lincolnshire after 1600 now contain fewer vascular plant species than ancient woods in the same district. About 40% of the vascular plant species in ancient woods have been unable to colonize new woodland even after 400 years, and there is no sign that they will do so eventually. While renewed attempts to plant more woodland on farmland are welcome because they create additional wildlife habitat, most of the characteristic and attractive plants of ancient woodland will not colonize without help.

INTRODUCTION

Today much is heard about set-aside and tree-planting on agricultural land (e.g. Insley, 1988). It is claimed that wildlife will benefit because species that were hitherto excluded from cultivated ground will colonize the new woodlands. In the long-term it is supposed that these new woods will steadily acquire more species until they are as rich as those woodlands inherited from the original forests. In England these assumptions can be tested by examining the wildlife in secondary woodlands, which have developed on former agricultural land over the last 400 years. I shall first outline the results from an examination of the vascular plants in secondary woods in central Lincolnshire, which developed since 1600, then review briefly the evidence from secondary woods elsewhere.

THE WOODS

Central Lincolnshire was originally covered in woodland, save perhaps for the fens beside the river Witham. Most was cleared more than 2000 years ago and, by 1086, the surviving woodland was reduced to a scatter of coppices and wood pastures (Foster and Longley, 1924). These fragments of the original woodland were further cleared in historic times until they were reduced to just 89 separate fragments covering a total of 2543 ha (see Fig. 3.5 below). Only 2.7% of the land area remained as woodland.

The cleared land was mostly used for farming, but there were periods when farming was unprofitable and land was abandoned or planted with trees (Thirsk, 1957). There were also fashions for landscaping the grounds of large houses or planting coverts for foxes and pheasants, and new woodland was created on old farmland for these reasons too. In this way a scattered population of secondary woods came into existence over the last 400 years, which now covers 2644 ha (2.9% of the land area) (Peterken, 1976). These woods grew up on all kinds of farmland, mainly ploughland, but also former meadows, pasture and heathland.

The history of all woodlands within the study area was determined by reference to historical sources, old maps, and topographical relationships (Peterken and Game, 1981; 1984). Each fragment of woodland was classified as either ancient or recent secondary.

FLORISTIC SURVEY

A list of 'woodland vascular plants' was constructed for the study area, including shade casters, shade bearers and edge species, but excluding grassland and other species, even though these were common on many woodland rides (Peterken and Game, 1984). Then lists were made of woodland plants from all 89 ancient woods and from 273 secondary woods. We were unable to gain access to a few secondary woods. Although all tree and shrub species were recorded, only herbs, small shrub species and climbers are included in the following analysis.

The species lists were unlikely to be complete, but the intensity of survey was roughly the same in each wood. A test of completeness led us to conclude that the lists were 80–90% complete.

ANALYSIS

Secondary woods were divided into two groups, those that grew on land next to ancient woods (adjacent secondary woods) and those that were separated from ancient woods by a tract of non-woodland (isolated secondary woods). Secondary woods were also classified according to their period of origin. Using old Ordnance Survey maps, those originating before 1820 were separated from those originating in 1820–1887, 1887–1946 and after 1946.

The number of species in each wood

The number of species in ancient woods increased as woods got larger (Fig. 3.1), although there was much variability that could not be explained. Recent woods showed a similar species-area relationship, but above 10 ha the number of species was less than the number in ancient woods for any given size of woodland (Fig. 3.2). Below 3 ha there was little difference. Even the smallest secondary woods had an irreducible minimum of 10–20 species. Adjacent secondary woods came between the two (Fig. 3.3). The fitted regressions of the three groups of woodland were significantly different.

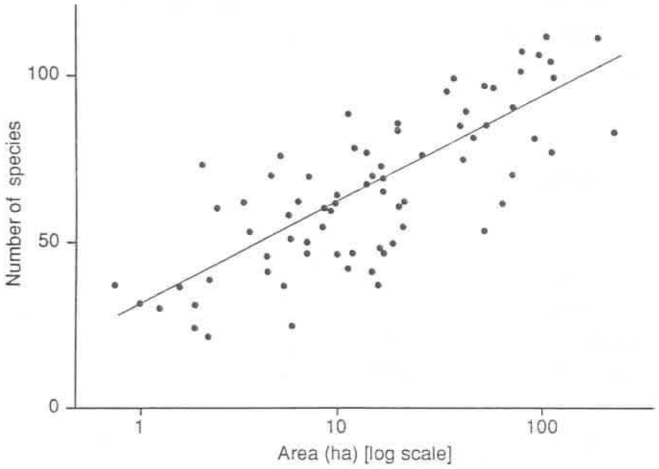

Fig. 3.1. The relationship between woodland area and number of species for the 89 ancient woods in central Lincolnshire. (From Peterken and Game, 1984.)

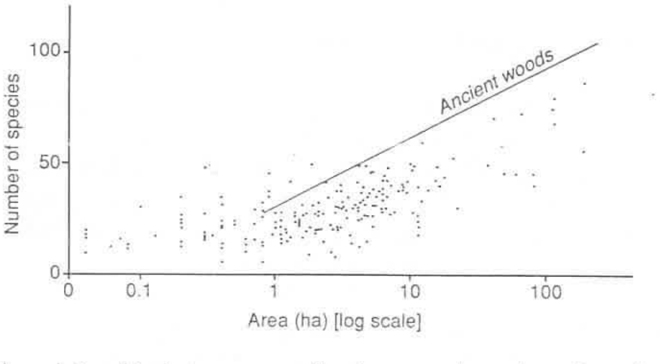

Fig. 3.2. The relationship between woodland area and number of species for 191 isolated recent woods in all regions and all periods of origin in central Lincolnshire. The species-area regression line obtained for ancient woods in central Lincolnshire (Fig. 3.1) is included for comparison. (From Peterken and Game, 1984.)

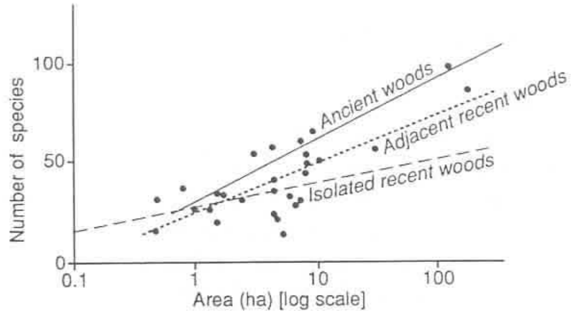

Fig. 3.3. The relationship between area and number of species for adjacent recent woods in central Lincolnshire. The species-area regression lines for ancient woods and isolated recent woods are shown for comparison. From Peterken and Game (1984).

Species in secondary woods

When examining those woods that grew up on farmland in isolation from ancient woods (i.e. excluding adjacent secondary woods and all secondary woods on former heathland), the most frequent species were those listed in Table 3.1. Without exception these are common and widespread throughout the British lowlands. They are essentially species of hedges, grassland, waste ground and gardens.

Very few species actually preferred secondary woods: most simply occurred in all types of woodland, although in ancient woods many were most abundant on the margins and disturbed ground. The four species that were positively associated with secondary woods (Table 3.2) were all widespread weeds of alkaline soils.

Do new woodlands get richer as they get older?

The species *versus* area relationships of different age classes of secondary woods (Fig. 3.4) were compared. Those originating before 1820 and those originating in 1820–1887 had an almost identical relationship. Those originating in 1887–1946 had more species in smaller areas, but the difference in slope between these and earlier woods was not significant. Woods originating after 1946 generally had fewer species, but the number of sites available was too few to test statistically.

The plant species in secondary woods appeared to build up quickly, but after about 100 years there was no further increase in total number of species. This was surprising, because some plants, such as *Mercurialis perennis*, were more likely to be found in older secondary woods than in younger secondary woods

Table 3.1. Vascular plant species found most frequently in secondary woods in central Lincolnshire. The proportion of all secondary woods in which each species was recorded is shown in 10% bands.

Galium aparine
90%
Rubus fruticosus
Urtica dioica
Glechoma hederacea
Geum urbanum
Poa trivialis
80%
Heracleum sphondylium
Moehringia trinervia
Stachys sylvatica
70%
Anthriscus sylvestris
Geranium robertianum
Hedera helix
Ranunculus repens
60%
Veronica chamaedrys
Viola odorata
Arctium minus
Epilobium angustifolium
Cirsium vulgare
50%
Rumex sanguineus
Brachypodium sylvaticum
Arrhenatherum elatius
Stellaria media
Dactylis glomerata
Dryopteris dilatata
Dryopteris filix-mas
Rumex obtusifolius
40%

Table 3.2. Vascular plant species that were strongly associated with secondary woodland in central Lincolnshire. These species have at least 75% of their localities in secondary woods. Secondary woods on former heathland have been excluded.

Aegopodium podagraria
Lamium album
Veronica hederifolia
Viola odorata

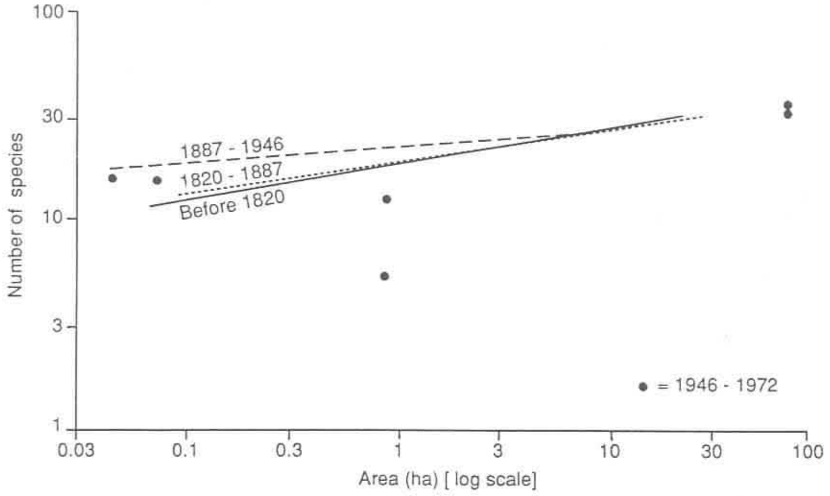

Fig. 3.4. The relationship between woodland area and number of species for four age classes of isolated secondary woodlands in central Lincolnshire. The fitted regressions for ›1820, 1820-1887 and 1887-1946 are given without data points. The six woods originating 1946-1972 are shown individually. Redrawn from Peterken and Game (1984).

(Peterken and Game, 1981). Furthermore, a study by Woodruffe-Peacock (1918) of a secondary wood near our study area showed that species continued to colonize through time by a variety of mechanisms. Presumably, some of the early colonists die out later.

Ancient woodland species

Ancient woods are richer than secondary woods because some species rarely colonize secondary woods. Ancient woods made up 25% of the sites listed and 49% of the woodland area, so if a species was randomly distributed through all woodland about 25–50% of all its locations should have been in ancient woods. In fact, 70 species (38% of all woodland species in the study area) were biased in their distribution towards ancient woods; that is, more than 50% of their localities were in ancient woods.

Table 3.3 lists the 30 species which were most strongly associated with ancient woods. Most must have been components of the original forest cover, which, for a variety of reasons, could not normally colonize new woodlands.

Ancient woodland plants in secondary woods

Nevertheless, most ancient woodland species occurred in a few ancient woods, and most secondary woods contained a few ancient woodland species. Many

Table 3.3. Vascular plant species strongly associated with ancient woodland in central Lincolnshire. Only the 30 species with 80% or more of their localities in ancient woods are listed. All species occur in at least nine sites, unless stated otherwise.

Anemone nemorosa
Calamagrostis canescens
Campanula trachelium (6 sites only)
Carex pallescens
Carex pendula

Carex remota
Carex strigosa (4 sites only)
Chrysosplenium alternifolium (4 sites only)
Convallaria majalis
Dipsacus pilosus

Equisetum sylvaticum (2 sites only)
Galium odoratum
Lamiastrum galeobdolon
Lathraea squamaria (1 site only)
Lathyrus montanus (3 sites only)

Luzula pilosa
Luzula sylvatica
Lysimachia nemorum
Lysimachia vulgaris
Maianthemum bifolium (1 site only)

Melampyrum pratense
Melica uniflora
Milium effusum
Neottia nidus-avis
Oxalis acetosella

Paris quadrifolia
Platanthera chlorantha
Potentilla sterilis
Vicia sepium
Vicia sylvatica (3 sites only)

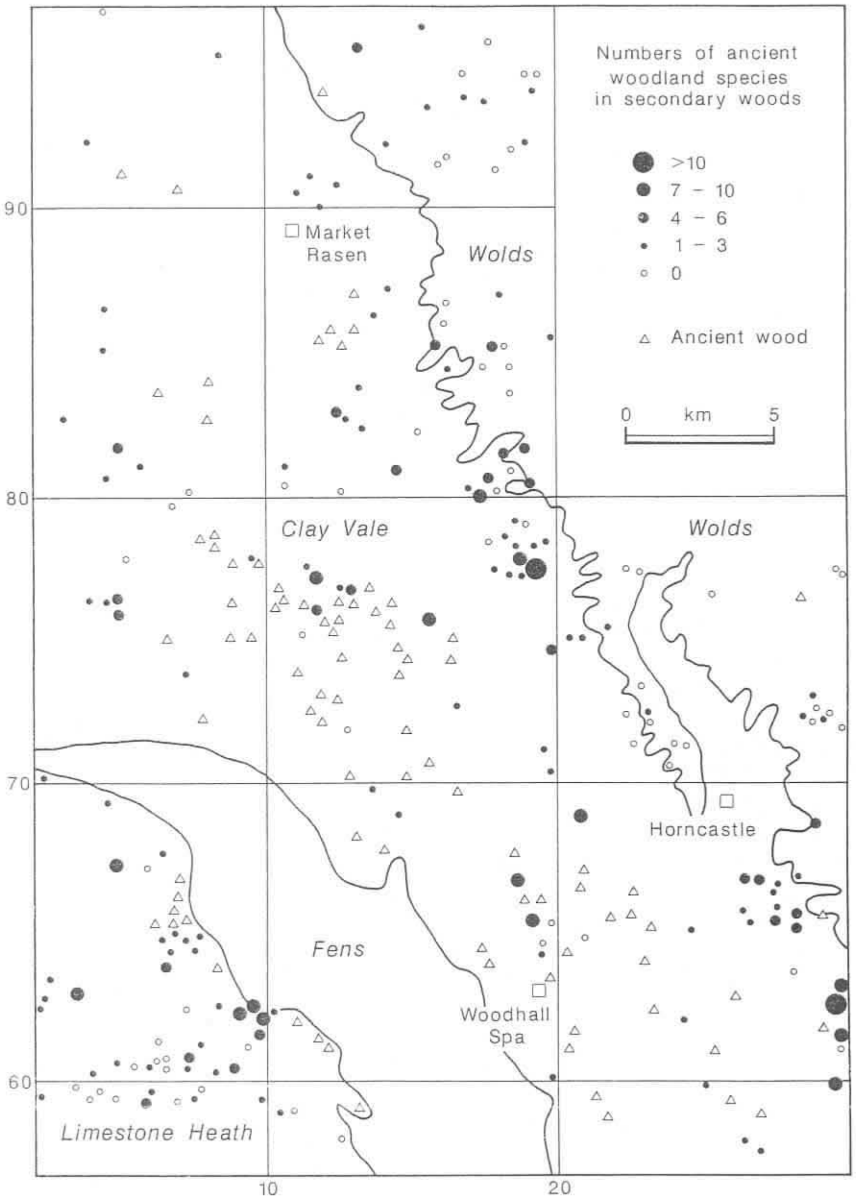

Fig. 3.5. The distribution of ancient woodland species in central Lincolnshire woods. The number of ancient woodland species in each wood is indicated.

were in adjacent secondary woods, that is, they had just 'hopped over the fence', but some were in isolated secondary woods. How did these species get into these woods?

Figure 3.5 shows the location of isolated secondary woods and how many of the 70 ancient woodland species each contained. Some had none and most had very few. Although the smallest numbers were found on the Wolds and Limestone Heath (well away from the concentrations of ancient woods) there was no obvious relationship with distance from ancient woods.

Throughout the district, a scatter of woods stood out as richer than their neighbours. The secondary woods that were richest in ancient woodland species are listed in Table 3.4. These woods tended to have one or more of the following features:

1. They were close to an ancient wood or directly linked in time through a wood-relic hedge (Pollard, 1973), or they had been close when they originated. Woodlands plants could have colonized new woodland from these ancient habitats without having to cross farmland.
2. They contained a headwater stream or were close to one. Small streams and the associated marshland commonly support woodland species, often in the semi-shaded, moist conditions also found in woodlands.
3. They grew on land beside or astride a parish boundary. These ancient boundaries often had substantial banks and hedges that provided stable refuges for woodland plants. Unfortunately, so many had been destroyed between 1945 and the start of the study in 1970 that their value as woodland habitats could not be properly assessed.
4. They covered a relatively large area. (The median secondary wood was about 2 ha.) Larger woods tend to cover a wider range of former land uses and touch a larger number of hedges, so their chance of being colonized by a particular woodland species is greater than that of smaller woods.
5. They originated before 1887. This means that woodland plants had had more than 100 years in which to colonize.

Every site in this list had at least one of these features and most had three of four. The poorer woods generally had one or none of these features.

The occurrences of ancient woodland species in isolated secondary woods were thus exceptions that proved the rule. The ancient woodland species were present because these woods had not in fact been ecologically isolated. They had perhaps long survived in a wood-relic hedge, colonized only a very short distance across unwooded territory, or survived in marshland, streamsides or ditches. This inference is supported by the presence today of such species in the few remaining examples of these habitats, even after 40 years of intensive modern farming. It is also possible that some of the secondary woods with many ancient woodland species were growing on land that had been pasture or meadow, rather than arable, before it reverted to woodland, but this has not been properly investigated.

Table 3.4. Characteristics of secondary woodlands in central Lincolnshire containing six or more ancient woodland species.

Secondary woodland	Area (ha)	Period of origin[b]	No. of ancient woodland spp.	Relation to ancient wood[a]	Stream through/ alongside wood	Parish boundary through/ alongside wood
Clay Close Holt	53	4	15	—	A	P
Wilksby Plantation	12	3	13	*	—	P
Stixwould Plantation	38	2	10	w	A	P
Sotby: Copt Hills and Brant Hills	22	3	10	—	A	P
Grantham's Cottage	6	4	10	*	—	P
Top Plantation	15	4	9	—	—	—
Metheringham Barff Farm East	>1	1	7	W	A	—
Metheringham Barff Farm West	>1	1	7	W	A	—
Metheringham Barff	3	2	7	W	A	—
Curtois Holt	7	4	7	*	—	P
Edlington Moor Farm	4	3	7	w	—	P
Goltho Pond	1	2	7	w	A	—
Coultas Wood	7	3	7	W	A	—
Panton Park	9	4	7	—	A	—

Revesby West Lane	18	3	7	—	A	P
Edlington Scrubs	20	4	7	—	—	P
Revesby Long Strip	8	3	7	*	—	—
Blankney Brickpits	5	2	6	—	A	—
Sudbrooke Park	4	4	6	—	A	—
Snarford Holt	3	4	6	—	A	—
Black Plantation	5	2	6	w	A	P
Lodge Covert	21	4	6	—	A	P
Fishpond Wood	1	4	6	—	A	—
Collow Holt	3	4	6	—	—	P
Croppersgorse Plantation	16	4	6	—	—	P
Normanby Dales	14	3	6	—	A	P
Guide Post Plantation	<1	3	6	w	—	—

[a] W = direct link with ancient wood (e.g. wood-relic hedge); w = <500 m from an ancient wood; * = 500–600 m from a large ancient wood.
[b] 4 = before 1820; 3 = 1820–1887; 2 = 1887–1946; 1 = after 1946.

SUMMARY OF FINDINGS IN CENTRAL LINCOLNSHIRE

Although much of the evidence is circumstantial, the broad picture that emerges from 300 years or more of 'set-aside' in central Lincolnshire can be summarized thus:

1. New woodlands on old fields quickly develop a flora of mainly hedgerow and garden 'weeds'.
2. They do not develop a rich woodland flora containing all the appropriate species of the original woodland, and will not do so even if they are given another 300 years.
3. This is because almost two-fifths of the original woodland flora is unable to colonize new woods, or does so only slowly and across short distances. There must have been few occasions when ancient woodland species have colonized across a large stretch of hostile territory.
4. New woods on old fields can develop a relatively rich flora if they incorporate habitats with some direct link in time and space with the original woodlands such as wood-relic hedges, naturally meandering streams, wet meadows and pastures.

SIMILAR OBSERVATIONS FROM OTHER REGIONS

Ancient woodland species of many kinds have been identified in many parts of Britain (Peterken, 1981). They include vascular plants, bryophytes (Ratcliffe, 1968), lichens, insects (Harding and Rose, 1986; Chapter 2) and molluscs (Boycott, 1934). They have also been identified in the USA (Whitney and Foster, 1988), The Netherlands (Hermy and Stieperaere, 1981) and Poland (Dzwonko and Loster, 1989). In many parts of Britain the woods growing on what was farmland can be rapidly distinguished by their flora from the ancient woods.

On the other hand, as one might expect, the difference between ancient woods and recent woods is much less where woodland density is high and farming has been mainly pastoral, with little cultivation. This supports the general diagnosis that this is a phenomenon of ecological isolation and soil changes brought about by cultivation.

FUTURE DEVELOPMENT OF THE FLORA OF NEW WOODLANDS

Any new woodland that is planted, or allowed to grow naturally, on what is now farmland will almost certainly replace arable crops or ley grassland, simply because there is very little other land left and conservationists want the few remaining patches of heathland, old grassland and wetland to remain unplanted. Most of this land will have been ploughed, fertilized and drained in recent years.

Furthermore, in most parts of lowland Britain a high proportion of the hedges have been removed, most streams have been straightened into ditches and even roadside verges have become so eutrophicated by fertilizer drift from nearby fields that they support only a limited range of rank grasses and tall herbs (Peterken and Hughes, 1990). Moreover, during the last 50 years, 8% of all ancient woodland – the principal refuges of the native woodland flora and fauna – have been destroyed by clearance (Spencer and Kirby, 1992) and many others may have been impoverished by coniferous plantations.

The new woodlands will therefore be established in a floristically degraded environment. The plants that will colonize first will usually be common and widespread species that grow strongly on dry, alkaline, enriched soils and woodland species with efficient dispersal mechanisms. Other woodland species (that is those of wet, acid or non-enriched soils, many of which colonize slowly) will be unable to colonize because there are now few relict locations from which they might spread and any propagule that does reach a new woodland will face overwhelming competition from vigorous herbs already established. In central Lincolnshire, in the future, even more than the 40% of the woodland flora which has not been able to colonize new woodland effectively for the last 400 years, may be restricted. However much one may wish otherwise, few of the new woods will acquire a full representation of woodland species, and the species that will not be there include some of the most characteristic and attractive.

If we wish these new woods to develop fully representative floras, we must site them close to ancient woods, crop the land for a few years without fertilizing, and plant or seed in those species that cannot readily colonize (Francis *et al* 1992). Where we lack ancient woods or ancient semi-woodland habitats and the soils cannot be stripped of nutrients, we must plant not only the trees but the whole woodland ecosystem.

ACKNOWLEDGEMENTS

Much of the research on which this chapter is based was undertaken jointly with Margaret Game. Roger Bolt helped to prepare Table 3.4 and Figure 3.3.